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**Psychological responses to fluctuating environments**

Much research has focused on the social systems and institutions that develop in response to unpredictable fluctuations in resources. For example, societies might buffer against shortfall by storing or diversifying resources, or by sharing them within and between communities (Winterhalder, 2007). By contrast, Quinlan et al. focus on individual-level psychological responses to fluctuating resources.

Quinlan et al. propose that exposure to unpredictable fluctuations in resources increases impulsivity. The logic of the hypothesis is that when environmental conditions are different than they were before, individuals experience a discrepancy between their current mental models of the world and their incoming sensory input. Individuals seek to resolve this discrepancy (not necessarily consciously) by collecting information about the current conditions. Spawning novel behaviors facilitates this discovery process: current conditions will differentially reinforce behaviors, enabling individuals to select the high-performing ones. Impulsivity, according to Quinlan et al., is the psychological generator of novel behaviors: it allows individuals to depart from their present mental models and learn about current conditions. This hypothesis is, to our knowledge, original.

Quinlan et al. test their hypothesis in a study of the Sidama people of Ethiopia. Some Sidama groups earn their living by traditional enset agropastoralism, and others by transitional maize farming. Enset production is low-risk, low-yield, and recovers slowly after crop loss. Maize production is high-risk, high-yield, and recovers quickly after crop loss. Quinlan et al. examine whether the association between impulsivity (two types: *careful control* and *acts without thinking*) and environmental risk (two types: *economic shocks* and *social shocks*) differs between these subsistence regimes. Their results are

complex, but overall suggest the impulsivity levels of maize farmers, who experience greater fluctuations in resources compared with enset farmers, are more responsive to environmental risk. This result seems to be consistent with the 'impulsivity as exploration' hypothesis.

**Exploration in response to fluctuation**

One assumption of Quinlan et al.'s argument is that it is adaptive to spawn novel behaviors and select high-performing ones in fluctuating environments. Whether this is true depends on several factors (Frank, 2007). For example, it might not be adaptive to 'try out' behaviors if the costs of maladaptive behavior are extremely high, as they might be in the case of learning about dangerous predators (Barrett, Peterson, and Frankenhuis, in press). However, in many conditions, reinforcement learning does provide a versatile mode of adaptation, as evidenced by mathematical modeling (Sutton and Barto, 1998) as well as its ubiquity in the natural world (Snell-Rood, 2012). Empirically, it would be interesting to examine whether in fluctuating environments, humans are indeed more likely to explore novel behaviors. A future study could investigate this question by comparing the range of the behaviors that Sidama maize and enset farmers use for the production of their crops, and by tracking whether the frequency of novel behaviors among maize farmers increases after changes in environmental conditions more than among enset farmers.

**Impulsivity as exploration of new cultural frames**

A separate question is whether impulsivity is the right process for generating novel behaviors. Quinlan et al. do not define impulsivity, but rather describe it as a cluster of psychological tendencies that includes a lack of premeditation, sensation

seeking, little self-regulation, and discounting of future over immediate rewards. Most psychologists agree there are different subtypes of impulsivity, although opinions differ over which subtypes exist. One distinction is that between *temporal impulsivity*, a preference for immediate rewards, and *reflection impulsivity*, acting without gathering or evaluating information (Caswell, Bond, Duka, and Morgan, 2015).

As temporal impulsivity entails action aimed at immediate rewards, it will also involve a focus on the present over the future (Fujita, 2011). A challenge to the linking of temporal impulsivity with exploration is the robust set of findings from psychology that attention toward temporal proximity is associated with attention toward spatial proximity: if one is focused on the 'now', one is also likely focused on the 'here', a state unconducive to exploration of 'elsewhere' (Trope and Liberman, 2010). Thus, any exploration resulting from impulsive behaviors would be local.

A challenge to the linking of reflection impulsivity with exploration is that acting without gathering information seems incompatible with impulsivity as information seeking. One might reconcile these notions, however, with the observation that reflection impulsivity concerns (little) information gathering *before* acting, and Quinlan et al.'s notion concerns information gathering *after* acting, based on the consequences of one's actions. If so, the authors might expand their proposed behavioral response to environmental fluctuation from that of 'Don't Think, Act', to 'Act First, then Watch to See What Happens'. A second concern about reconciling reflection impulsivity with cultural exploration is that impulsive behaviors do not necessarily involve rejection of a cultural pattern: in fact, some 'impulsive' behaviors involve mindlessly going along with a cultural ritual or norm (such as a dance, or eating habit), for the sake of immediate

rewards; conversely, culturally anomalous behaviors (such as refraining from procreation) may result from reflective, self-controlled information-processing.

**Impulsivity as an adaptive focus on the present**

We suggest impulsivity be construed in line with the approach of life history theory, namely, as an adaptive regulatory shift toward the present, in response to shocks (whether social or crop-related) received in unpredictable environments (Belsky, Steinberg, and Draper, 1991; Ellis, Figueredo, Brumbach, and Schlomer, 2009; Frankenhuis, Panchanathan, and Nettle, 2016), the latter arguably characterizing the life of the maize farmer. A version of this explanation would fit well with Quinlan et al.'s evidence of greater regulatory shifts in response to environmental shocks in Sidama maize than enset farmers—evidence that makes a solid contribution to a growing literature on the evolution of plasticity in readiness for the fluctuations of life.

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